Remarks

In the outstanding Office Action, the Examiner rejected claims 40 and 41 as anticipated by Vesely (U.S. Patent No. 5,817,022). Claims 42 and 43 were rejected as unpatentable over Vesely in view of Weng et al. (U.S. Patent No. 5,782,766). Claims 44-46 were rejected as being unpatentable over Vesely in view of Weng et al. and further in view of Ji et al. (U.S. Patent No. 6,110,117). Applicants respectfully request reconsideration of the rejections.

Claims 40-41 are patentable:

Claim 40 defines an ultrasonic imaging method comprising (a) acquiring image data as defined, (b) generating a first extended field of view image from image data associated with a first phase of the physiological cycle from multiple selected ones of the frames of (a) associated with the first phase of the physiological cycle and acquired from substantially co-planar, partially overlapping spatial regions, (c) generating a second extended field of view image associated with a second phase of the physiological cycle from image data from multiple selected ones of the frames of (a) associated with the second phase of the physiological cycle and acquired from substantially coplanar, partially overlapping spatial regions; and displaying at least the first and second extended field of view images in sequence to a user. Claim 41 defines an ultrasonic imaging system corresponding to claim 40.

Applicant submits that the invention of claim 40 is neither disclosed nor suggested by Vesely. In particular, the passage in Vesely at column 2, lines 35-64 relates to the creation of images within a three-dimensional volume of the heart (column 2, line 61). The 3-D data set described in this passage is created from 100 adjacent imaging planes that are positioned beside one another and slightly spaced away from one another (column 2, lines 49-53). In the example given, 30 images are acquired during one heart cycle at each of the imaging planes (col. 2, lines 43-51). Vesely divides the heart cycle into 30 phases, so that 30 different 3D data sets are generated (col. 2, lines 56-62). For one phase, data corresponding to 100 different, spaced apart imaging planes represents the 3D volume of the heart. 30 such

representations are generated corresponding to the 30 phases of the single heart cycle used by Vesely (col. 2, lines 62-63).

This is quite different from the invention of Claim 40, in which the first and second images are extended field of view images generated from image data acquired from substantially co-planar, partially overlapping spatial regions. Vesely acquires 30 images at a same imaging region and then moves the imaging region to an adjacent spaced apart region for acquiring 3D volume data. Vesely does not acquire data from "partially" overlapping spatial regions. Vesely is concerned with acquiring data for 3D volume, not a co-planar extended field of view.

Claim 40 also requires that the first and second extended field of views are generated from multiple sets of image data associated with first and second phases, respectively, of the physiological cycle where the extended field of view images generated from image data acquired from substantially co-planar, partially overlapping spatial regions. Vesely acquires one image for each of the 100 imaging regions for each of the 30 phases of the cycle. Vesely does not suggest imaging a co-planar or even same region multiple times at the same phase of the cycle. Vesely is concerned with generating 3D volume data at different phases, not a co-planar extended field of view image made from multiple sets of data representing partially overlapping regions and the same phase (i.e. the first or second phase).

The grounds for patentability discussed above apply with equal force to Claim 41, and for all these reasons, Applicant submits that Claims 40 and 41 are patentable over Vesely.

Claims 42 and 43 are patentable:

Independent Claim 42 includes the acts of (b) extracting a time reference based on a Doppler characteristic of the image data of (a), and (c) identifying each frame with a respective phase of a physiological cycle based at least in part on the time reference of (b). Neither of Vesely nor Weng et al. disclose these acts.

The Examiner alleges in paragraph 4 that Vesely discloses acts of (b) extracting a time reference based on a Doppler characteristic of image data and of (c) identifying each frame with a respective phase based at least in part on the time reference.

However, the Examiner then acknowledges that Vesely fails to disclose a Doppler characteristic of the image data. In addition, Vesely does not disclose extracting a time reference based on image data regardless of the type of characteristic. Vesely discloses acquiring 30 images during a heart beat (col. 2, lines 46-51). According to Vesely, a heart beat is assumed to last one second and the system is assumed or set to acquire 30 frames a second (col. 2, lines 39-43). Vesely relies on relative timing of events. There is no disclosure of any further synchronization, not even using an EKG device connected with the system to determine a phase of the cycle. Vesely relies on relative timing, fails to suggest extracting a time reference from the image data and fails to suggest extracting the time reference based on a Doppler characteristic of the image data. Accordingly, Vesely also does not suggest identifying each frame with a respective phase based on such a time reference.

Weng et al. disclose generating an extended field of view Doppler velocity or power image (col. 3, lines 47-54). Doppler data is merely used to overlay an extended field of view image. However, there is no suggestion to use the Doppler image information for extracting a time reference nor identifying each frame with a respective phase based on the time reference.

The Examiner cites to the Weng et al. disclosure of correlation at col. 2, line 63-col. 3, line 12. However, the correlation is used to determine motion between two images. Since images are correlated, the movement of the transducer and associated image plane between images is tracked. The two images are then aligned as function of the determined motion for forming the extended field of view (see Figures 2 and 9). Weng discloses determining motion from the image data, but does not disclose extracting a time reference. Weng et al. also do not disclose extracting a time reference from Doppler information. Since Weng et al. are concerned with real-time motion tracking of consecutive image frames (col. 4, lines 32-45), there is not a disclosure of timing acquisition relative to a physiological cycle. Weng et al. do not suggest identifying each frame with a respective phase nor identifying each frame with a respective phase based on the claimed time reference.

Claim 43 depends from claim 42 so is allowable for the same reasons. Furthermore, claim 43 requires extracting the time reference based on a maximum

Doppler velocity or energy. Weng et al. only disclose Doppler velocity or power imaging, not extracting based on a maximum value.

Claims 44-46 are patentable:

Claims 44-46 depend from claim 42 so are allowable for the same reasons discussed above. Ji et al. do not provide the missing extraction or identification acts. The cited disclosure of Ji et al. discusses common techniques to determine Doppler velocity and energy. For example, a mean value or instantaneous frequency or velocity value can be used (col. 3, lines 25-45). There is no suggestion to extract a time reference from the Doppler information or identify each frame with a respective phase of a physiological cycle.

Claim 44 requires that the extracting a time reference act comprise assessing mean Doppler energy for a plurality of frames. Ji et al. disclose Doppler energy for imaging, but not assessing mean energy for a plurality of frames to extract a time reference.

Claim 45 is allowable for the same reasons as claim 44. Furthermore, claim 45 requires detecting one of the frames characterized by a maximum mean Doppler energy in addition to assessing the mean energy for a plurality of frames. Ji et al. disclose Doppler energy imaging, but not detecting one of a plurality of frames where the one frame is associated with a maximum energy.

Claim 46 is allowable for the same reasons as claims 42 and 40.

Conclusion

Applicant submits that new Claims 40-46 are all in condition for allowance in view of the foregoing remarks. Reconsideration is respectfully requested. If the Examiner believes an interview would be helpful to resolve any outstanding concerns, please call the undersigned at (312) 321-4726.

Respectfully submitted,

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